5 Water Heating Requirements

5.1 Overview

5.1.1 Water Heating Energy

Water heating energy use is an important end use in low-rise residential buildings. Roughly 90 percent of California households use natural gas fueled water heaters, typically storage gas units with tank volumes of 40 to 50 gallons. Standby loss associated with the center flue gas storage water heater design contributes 25-35 percent of a typical gas storage water heater system's annual energy use.

Whereas natural gas, (liquefied petroleum gas), LPG or oil can be burned directly to heat water, electricity is typically generated in a fossil fueled power plant where approximately two-thirds of the energy used to produce the electricity is lost in the generation, transmission, and distribution processes. The Standards require space conditioning and water heating systems to account for hourly usage impacts of the overall efficiency of each fuel type in the form of Time Dependent Valuation (TDV). Due to inefficiencies associated with generation and transmission, electric TDV essentially precludes the use of standard electric water heaters. Only electric heat pump water heaters, with significantly higher efficiencies than electric storage units, are closer to the efficiency of typical gas systems, even after accounting for TDV impacts.

The figure below shows the energy flows that determine water heating energy usage. On the right hand side, hot water draws at the end use points define a load pattern that is imposed on the hot water distribution system that delivers water from the heating device to the use points. The heating device must meet this recovery load minus any contribution from auxiliary heat inputs, such as a solar thermal system. Energy use for water heating encompasses all energy uses; therefore, considerations of issues such as standby losses from the water heater or supplemental storage pump energy for recirculation systems, or impacts from supplemental heating must be considered in selecting a water heater that will comply.

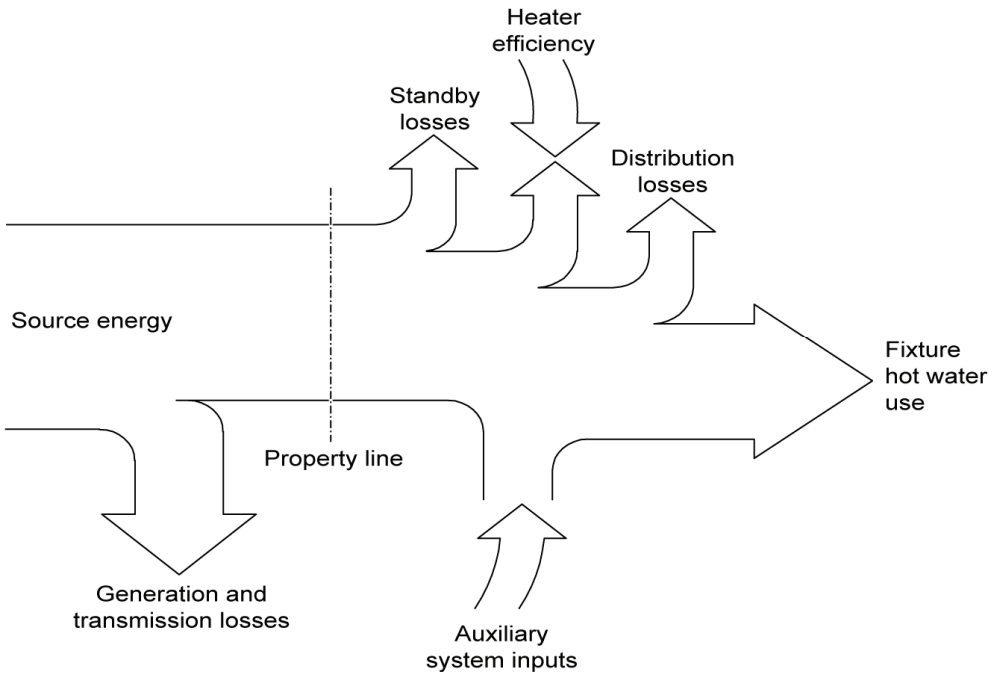

Figure 5-1 – Energy Flows for Water Heating

5.1.2 What's New for 2008

The key changes in water heating code from 2008 are listed below:

Instantaneous (or tankless) water heaters including gas, oil, small electric, and large instantaneous, indirect gas water heaters and hot water supply boilers will have their performance degraded to better account for the impacts of thermal cycling and small hot water draws on the heat exchanger that are not currently reflected in the Energy Factor test procedure. The Residential ACM Manual will derate tankless water heater performance by multiplying the rated EF by a 0.92 factor.

Parallel piping (or home run) systems that feature a manifold will require a 15 ft maximum pipe length between the water heater and the manifold. The design goal is to minimize this length since most of the water in a manifold system is upstream of the manifold. The 15 ft limit will eliminate excessive pipe lengths that contribute to poor manifold system performance.

Distribution system multipliers have been added or updated for several cases including:

- Piping installed below grade (both insulated and uninsulated)
- Demand recirculation systems (two control options are now available)
- Temperature buffering tank (a small electrically heated tank installed downstream of a tankless water heater to minimize supply temperature fluctuations)

For multi-family systems new requirements have been added to assure proper performance of water heaters. These measures include:

- Air release valve to prevent pump cavitating
- Check valves to prevent backflow
- Pump isolation valves to allow pump servicing
- Pump Priming valve to allow to allow air bleeding of the system

In addition to the new installation requirements changes have been made to allow for credit for central DHW monitoring and hourly demand controlled supply controls.

5.1.3 Water Heater Types

The following water heater types are recognized by the standards.

- Standard Water Heater - Storage Gas
- Large Storage Gas
- Storage Electric
- Heat Pump Water Heater with storage
- Instantaneous (Tankless) Gas
- Instantaneous (Tankless) Electric
- Boiler

5.1.4 Distribution System Types

The water heating distribution system represents the piping, pumps and controls that deliver hot water from the water heater to end-use points within the building. The assumed “standard” distribution system for a system serving a single dwelling unit is based on a trunk and branch design with no recirculation pumps and pipe insulation on the hot water line(s) running from the water heater to the kitchen fixtures and the first five feet of piping on the inlet and outlet from the water heater (see Mandatory Requirements).

The Standards recognize alternative distribution systems that may be more or less efficient than the standard system. Table 5-1 gives brief definitions for all of the recognized distribution system types serving a single dwelling unit.

Table 5-1 –Description of Distribution Systems within a Dwelling Unit

Distribution Systems	Description
Standard (STD)	Standard system without any pumps for distributing hot water. The first 5 ft of pipes from the storage tank is insulated for both hot and cold water pipes. Pipes from the water heater to the kitchen must be insulated per §150(j).
Pipe Insulation (PIA)	All hot water pipes are insulated per the requirements of §150(j).
Standard Pipes with no Insulation (SNI)	Standard distribution system (STD) with no pipe insulation on lines to the kitchen.
Point of Use (POU)	System with no more than 8 ft horizontal distance between the water heater and hot water fixtures, except laundry.
Parallel Piping (PP)	Individual pipes radiate from a manifold near the water heater to each of the fixtures.
Uninsulated Pipe Below Grade (UPBG)	Piping installed below grade (outside of conditioned space) with no insulation.
Insulated and Protected Pipe Below Grade (IPBG)	Piping installed below grade (outside of conditioned space) with insulation and a protective covering.
Recirculation No Control (RNC)	Distribution system using a pump to recirculate hot water though a hot water loop that serves the individual use points. Pump operation and water flow are continuous. Pipe insulation is required per §150(j).
Recirculation with Timer Control (RTm)	Recirculation system that uses a timer control to control pump operation based on time of day. Pipe insulation is required per §150(j).
Recirculation with Temperature Control (RTmp)	Recirculation system that uses a remote temperature sensor attached to the hot water return line to cycle pump operation to maintain water temperatures within certain limits. Pipe insulation is required per §150(j).
Recirculation with Timer and Temperature Control (RTmTmp)	Recirculation system that uses both temperature and timer controls to regulate pump operation. Pipe insulation is required per §150(j).
Recirculation with Manual Demand Control (RDmc)	Recirculation system that uses brief pump operation to recirculate hot water to fixtures when a demand for hot water is initiated with push button control activation. Pipe insulation is required per §150(j).
Recirculation with Motion Sensor Demand Control (RDmc)	Recirculation system that uses brief pump operation to recirculate hot water to fixtures when a demand for hot water is initiated with motion sensor control activation. Pipe insulation is required per §150(j).
Temperature Buffering Tank (TBT)	A distribution system with a small storage electric water heater installed in the distribution system.

There are separate distribution system definitions and requirements for water heating systems that serve multiple dwellings. The terms “Standard,” “Point of Use,” “Standard Pipes with No Insulation “and “Parallel Piping” do not apply to systems serving multiple dwellings. The term “Pipe Insulation” has a different meaning for central water heating systems than for systems serving a single dwelling unit. Piping for recirculation loops is required by the mandatory measures to be insulated, but a higher level of insulation can also save energy and is recognized by the compliance software programs.

Additionally, more information is required for demonstrating compliance of systems serving multiple dwelling units. The compliance documentation must specify the length of piping that is inside the building, outside, or underground, and the insulation R-value on each portion.

The base case system used to develop the standard budget for central water heating assumes a minimal amount of piping outside and none underground. It also assumes a recirculation pump with a timer control, and R-4 or R-6 insulation on the pipes (depending upon pipe diameter). The proposed system also is assumed to have a recirculation pump, but with whatever controls (or lack of them) that the user designates. An exception to this assumption is made for systems serving six or fewer dwelling units when no recirculation pump is installed.

5.1.5 Solar Water Heating Calculations

Solar water heating can be used as a tradeoff under the performance approach. So solar water heating is also required if prescriptive package C is used. Additionally, solar may be used in combination with an alternative water heater to show equivalency with the standard water heater requirement in the prescriptive packages. The building standards use solar fraction (SF) to determine the impact of the solar water heating systems. The SF is the percent of the total energy required by the water heating system that is provided by the solar system. Note that systems used for compliance must have received a rating by the Solar Rating and Certification Corporation (SRCC). To calculate this value two options have been provided. The first approach uses the Solar Energy Factor (SEF) OG300 rating determined by the SRCC to rate predesigned solar water heating systems. To convert this value into a SF use the calculator located at this website:

http://www.gosolarcalifornia.ca.gov/builders/swh_calc_systems.html.

The other option is to use the SRCC OG100 rating for collectors. When using this approach the designer selects the type and number of collectors, storage volume, as well as the tilt and orientation of the collectors. This approach should be used to be design systems for multifamily buildings. To use this approach go to the following website to download the calculator:

http://www.gosolarcalifornia.ca.gov/builders/swh_calc_collectors.html.

5.2 Mandatory Requirements

5.2.1 Equipment Certification

§113(a)

Manufacturers must certify that their products comply with the Appliance Efficiency Regulations at the time of manufacture. Regulated equipment may not be sold in California unless certified. Regulated equipment includes the following types of water heaters:

- Gas or propane water heaters and boilers

- Heat pump water heaters
- Electric water heaters and boilers
- Oil-fired water heaters and boilers

5.2.2 Equipment Efficiency

§113(b), §111

Small water heaters are regulated by federal standards. The efficiency requirements for such equipment are given in Table 5-2 below. The efficiency rating for most residential water heaters is the Energy Factor (EF). The intent of the EF test procedure is to represent the overall annual efficiency of a water heater, combining the effects of recovery efficiency and standby losses. During the test, 64.3 gallons of hot water is withdrawn in six equal draws at one hour intervals and then the water heater sits idle for the remaining 24 hour period. Set point temperatures and inlet temperatures are standardized for the test. The Energy Factor (EF) for water heaters other than heat pump water heaters varies between zero and one. Typical EF's for gas water heaters range from about 0.6 (gas storage) to 0.8 (instantaneous). Typical electric water heater EF's range from about 0.9 (electric storage) to over 2.0 (heat pump water heaters).

Table 5-2 – Minimum Energy Factor Small Water Heaters

Source: Energy Commission Appliance Efficiency Regulations, Table F-4 – Standards for Small Federally-Regulated Water Heaters

Type	Size	Energy Factor (EF)
Gas Storage	≤ 75,000 Btu/hr	0.67-(0.0019*V)
Gas Instantaneous	≤200,000 Btu/hr	0.62-(0.0019*V)
Oil Storage	≤105,000 Btu/hr	0.59-(0.0019*V)
Oil Instantaneous	≤210,000 Btu/hr	0.59-(0.0019*V)
Electric Storage (exc. Table top)	≤ 12KW	0.97-(0.00132*V)
Electric Table Top	≤ 12KW	0.93-(0.00132*V)
Electric Instantaneous (exc. table top)	≤ 12KW	0.93-(0.00132*V)
Heat pump Water Heater	≤ 24 Amps	0.97-(0.00132*V)
Note: V = tank volume (gal). Effective Date January 20, 2004		

The energy efficiency of equipment that is larger than the sizes indicated in Table 5-2, are regulated by the California Appliance Efficiency Regulations. Energy factor is not used for larger equipment, but rather minimums are specified for thermal efficiency and standby loss as shown in Table F-3 (see Appendix B).

It is not necessary to verify the minimum efficiency of new water heaters at the building counter when the prescriptive method is used, since this is an appliance standard and applies at the point of sale. Under the performance approach, water heater efficiency may be a factor in compliance. Therefore, when performance compliance is used, any water heater that has an efficiency rating higher than the minimal standard should be properly documented.

5.2.3 Pipe Insulation

§150(j)2 Pipe Insulation

Pipe insulation is a mandatory requirement in the following cases:

1. Non-recirculating systems must have pipe insulation on both hot and cold water pipes for a length of five feet from the water heater, regardless of whether the piping is in conditioned space.
2. The entire length of recirculating distribution sections of domestic hot water systems must be insulated, regardless of whether the piping is buried or exposed.
3. Indirect fired domestic hot water system piping from the heating source to the storage tank.

Piping *exempt* from the mandatory insulation requirement includes:

1. Factory installed piping within space conditioning equipment.
2. Piping that penetrates framing members is not required to have insulation where it penetrates the framing. However, if the framing is metal then some insulating material must prevent contact between the pipe and the metal framing.
3. Piping located within exterior walls other than for a recirculation loop, does not need to be insulated if all the requirements for Insulation Installation Quality are met (See Reference Residential Appendix RA4.4).
4. Piping located in the attic does not need pipe insulation if it is continuously buried by at least 4 inches of ceiling insulation.
5. Piping that serves process loads, gas piping, cold domestic water piping (other than within five feet of the water heater), condensate drains, roof drains, vents, or waste piping.

Other installation information:

1. No insulation should be installed closer than 6 inches from the flue. If possible, bend the pipe away from the flue. Otherwise, it may be necessary to stop pipe insulation short of the storage tank (see *2007 California Mechanical Code*, Chapter 3, Table 3-3).
2. All pipe insulation seams should be sealed.
3. Installed piping may not be located in supply or return air plenums.
4. Hot and cold water piping, when installed in parallel runs should be a minimum of 6 inch apart.
5. If a fire wall interrupts the first 5 ft of pipe, the insulation may be interrupted at the wall and continued on the other side.
6. Insulation for pipe elbows should be mitered and insulation for tees should be notched.

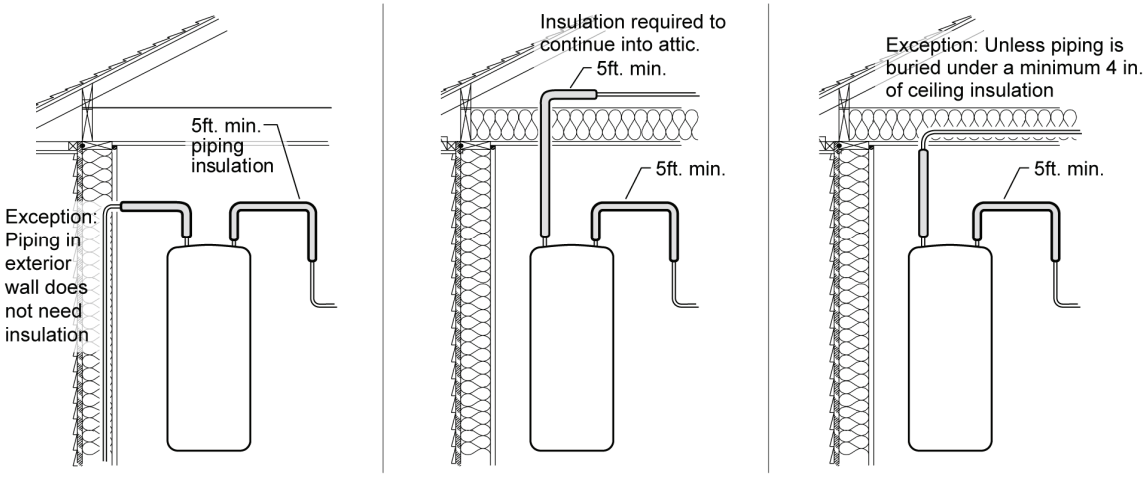

Figure 5-2 – Pipe Insulation Requirements First Five Feet from Water Heater

Standards Table 150-B

Where insulation is required as described above, one inch of R-4 insulation is typically required. This requirement applies to domestic hot water pipe (above 105° F) when the pipe diameter is 2 inches or smaller, the water temperature is between 105°F and 200°F, and the insulation conductivity between 0.24 and 0.28 Btu-in/hr-ft²-°F (typical of cellular foam pipe insulation material). One and one half inch insulation is required on pipes greater than 2 inches.

5.2.4 Insulation Protection

§150(j)3

If hot water piping insulation is exposed to weather, it must be suitable for outdoor service. For typical cellular foam pipe insulation, this means protection with aluminum, sheet metal, painted canvas, plastic cover, or a water retardant paint coating that shields from solar radiation.

5.2.5 Certification of Showerheads and Faucets

§110(a)

Maximum flow rates are set by the Appliance Efficiency Regulations, and all faucets and showerheads sold in California must meet these standards. The limits for showerheads are 2.5 gallons per minute (gpm) at 80 psi water pressure. The limit for lavatory faucets and kitchen faucets is 2.2 gpm at 60 psi.

5.2.6 Storage Tank Insulation

§150(j)1 Tank Insulation

Exterior tank insulation is required in some cases to encourage water heater performance above the current federal minimum efficiency levels. A minimum

R-12 tank wrap is a mandatory requirement for small storage water heaters, which have an input rating equal to or less than 75,000 Btus per hour that use gas, or propane water heaters and have an energy factor equal to the federal minimum level. Water heaters that exceed the minimum EF or large storage water heaters with a rated input greater than 75,000 Btu/h (these units are not rated with EF) are not required to have an external R-12 insulation blanket.

§113(c)4

Any unfired tanks (used as a back-up for solar water heating or as storage for a boiler) must either be insulated externally with R-12 or have a label indicating the tank is internally insulated with R-16. Alternatively, a tank can comply with this mandatory measure if calculations are provided that show that the average heat loss is less than 6.5 Btu/hr-ft² when there is a temperature difference of 80°F between the water in the tank and the ambient air.

5.2.7 Water Heating Recirculation Loops Serving Multiple Dwelling Units

§113(c)5

Multi-family building may have individual water heaters for each unit, but they are more likely to have a central water heating system with a recirculation loop that supplies each of the units. This recirculation loop is comprised of a supply portion, of larger diameter pipe connected to smaller diameter branches that serve multiple dwelling units, guest rooms, or fixtures and a return portion that completes the loop back to the water heating equipment. The large volume of water which is recirculated during periods of high use creates situations that require the installation of certain controls and servicing mechanisms to optimize performance and allow for lower cost of maintenance.

Air Release Valves

§113(c)5A

The constant supply of new water and the operation of pumps creates the possibility of the pumps cavitating due to air in the water. Cavitation means that cavities or bubbles are forming in the liquid that we're pumping. These cavities form at the low pressure or suction side of the pump, causing several things to happen. The cavities or bubbles will collapse when they pass into the higher regions of pressure, causing noise, vibration, which may lead to damage to many of the components. In addition there is a loss in capacity and the pump can no longer build the same head (pressure). Ultimately the pumps' efficiency and life expectancy drops.

Cavitating can be minimized by either the installation of an air release valve or mounting the pump vertically. An inlet side of the recirculation pump and for inspection purposed they must be no more than 4 ft from the pump. The air release valve must be mounted on a vertical riser with a length of at least 12 inches.

Backflow Prevention In Recirculation Loop

§113(c)5B

Temperature and pressure differences in the water throughout a recirculation system can create potentials for backflows. Backflow can result in either hot water flowing up cold water lines or cold water flowing up hot water lines.

To prevent this from occurring, the Standards require that a check valve or similar device be located between the recirculation pump and the water heating equipment.

Equipment For Pump Priming/Pump Isolation Valves

§113(c)5C&D

A large number of systems are allowed to operate until complete failure simply because of the difficulty of repair or servicing. By requiring specific measures to be included during initial construction, repair labor costs can significantly reduced. The measures which have been included to address this issue are equipment for pump priming and pump isolation valves.

To meet the pump priming equipment requirement, a hose bib must be installed between the pump and the water heater. In addition, an isolation valve shall be installed between the hose bib and the water heating equipment. This configuration will allow the flow from the water heater to be shut off, allowing the hose bib to be used for bleeding air out of the pump after pump replacement.

The requirement for the pump isolation valves will allow replacement of the pump without draining a large portion of the system. The isolation valves shall be installed on both sides of the pump. These valves may be part of the flange that attaches the pump to the pipe. One of the isolation valves may be the same isolation valve as in item C.

Connection of Recirculation Lines

§113(c)5E

While proper installation seems like an over simplified request, the fact is that improper installations do occur. Manufacturer's specifications should always be followed to assure optimal performance of the system. The cold water piping and the recirculation loop piping should never be connected to the hot water storage tank drain port.

Backflow Prevention In Cold Water Supply

§113(c)5F

The dynamic between the water in the heater and the cold water supply are similar to those in the recirculation loop. Thermosyphoning can occur on this side of this loop just as it does on the recirculation side of the system. To prevent this, the Standards require a check valve to be installed on the cold water supply line. The valve should be located between the hot water system and the next closest tee on the cold water supply line. Note that the system shall comply with the

expansion tank requirements as described in the California Plumbing Code Section 608.3.

5.2.8 Solar or Recovered Energy in State Buildings

§113(c)6

Low-rise residential buildings constructed by the State of California shall have solar water heating systems. The solar system shall be sized and designed to provide at least 60 percent of the energy needed for service water heating from site solar energy or recovered energy. There is an exception when buildings for which the state architect determines that service water heating is economically or physical infeasible. See the Compliance Options section below for more information about solar water heating systems.

Example 5-1

Question

Under what circumstances is a constantly (or continuously) burning pilot light prohibited on certain appliances?

Answer

For compliance with the building standards, §115 prohibits continuously burning pilot lights for some natural gas burning equipment (this does not include liquefied petroleum gas burning appliances). §115 prohibit continuous pilots on the following types of equipment:

• Household cooking appliances with an electrical supply voltage connection in which each pilot consumes 150 Btu/hr or more

• Pool heaters

• Spa heaters

• Fan type central furnaces

§150 (e) prohibits continuously burning pilot lights for:

• Fireplaces

• Decorative gas appliances

• Gas logs

Therefore water heaters may have a standing pilot light. This is allowed because the heat from the pilot helps maintain the water temperature in the tank.

Example 5-2

Question

I thought I was supposed to insulate hot and cold water piping from the water heater for either the first 5 ft or the length of piping before coming to a wall, whichever is less. Did I misunderstand?

Answer

Yes. The requirement is that you must insulate the entire length of the first 5 ft, regardless of whether there is a wall (§150(j)2). You have two options: (1) interrupt insulation for a fire wall and continue it on the other

side of the wall or (2) run the pipe through an insulated wall, making sure that the wall insulation completely surrounds the pipe. The reason for this requirement is that when heated, the water expands and pushes hot water out the cold water line. This can start thermosyphoning, which continues to remove heat from the stored water. The insulation helps reduce this effect.

Example 5-3

Question

When I'm insulating the pipes for a recirculating water-heating system, I understand that I must insulate the entire length of hot water pipes that are part of the recirculation loop. Do I also need to insulate the runouts?

Answer

No. Since the water in runouts does not recirculate, they do not need to be insulated.

5.2.9 Pool and Spa Equipment

Pool and Spa Overview

The mandatory requirements for pool and spa heating equipment are essentially the same as in the 2005 Standards. The 2008 Standards include many additional requirements for residential swimming pool filtration equipment which affect pump selection and flow rate, piping and fittings, and filter selection. These new Standards are designed to reduce the energy used to filter and maintain the clarity and sanitation of pool water.

Heating Equipment Requirements

Before any pool or spa heating system or equipment may be installed, the manufacturer must certify to the Energy Commission that the system or equipment complies with §114 and §115. The requirements include minimum heating efficiency according to Appliance Efficiency Regulations, an on-off switch outside the heater, permanent and weatherproof operating instructions, no continuous pilot light, and no electric resistance heating (see exceptions below).

§115

Pool and spa heaters may not have continuously burning pilot lights.

§114

Outdoor pools and spas with gas or electric heaters shall have a cover installed. The cover should be fitted and installed during the final inspection.

There are two exceptions for electric heaters, which may be installed for:

1. Listed package units with fully insulated enclosures (e.g., hot tubs), and with tight-fitting covers, insulated to at least R-6.
2. Pools or spas getting 60 percent or more of their annual heating from site solar energy or recovered energy.

Pool Pump Requirements

For maximum energy efficiency, pool filtration should be operated at the lowest possible flow rate for a time period that provides sufficient water turnover for clarity and sanitation. Auxiliary pool loads that require high flow rates such as spas, pool cleaners, and water features, should be operated separately from the filtration to allow the filtration flow rate to be kept to a minimum.

§150 (p)1

All pumps and pump motors shall comply with the specifications of the Appliance Efficiency Regulations.

The pool filtration flow rate may not be greater than the rate needed to turn over the pool water volume in 6 hours or 36 gpm, whichever is greater. This means that for pools of less than 13,000 gallons the pump must be sized to have a flow rate of less than 36 gpm and for pools of greater than 13,000 gallons, the pump must be sized using the following equation:

$$\text{Max Flow Rate (gpm)} = \frac{\text{Pool Volume (gallons)}}{360\text{min.}}$$

These are maximum flow rates. Lower flow rates and longer filtration times are encouraged and will result in added energy savings.

Pools with auxiliary pool loads must use either a multi-speed pump or a separate pump for each auxiliary pool load. For example, if a spa shares the pool filtration system, either a multi-speed pump must be used or a separate pump must be provided to operate the spa. If the pool system can be served by one pump of less than 1 total-hp in capacity, the pump may be single speed.

Filtration pump motors with a capacity of 1 total-hp or more must be multi-speed.

All pool pumps sold in California must be tested and listed with the Energy Commission according to the Appliance Efficiency Regulations. Pump manufacturers must list flow rate, power, and energy factor at each of three system curves (see Figure 5-3). For pools equal to or less than 17,000 gallons, a pump must be chosen such that the flow rate listed for Curve A is less than the 6-hour turnover rate. For pools greater than 17,000 gallons, a pump must be chosen such that the listed flow rate at Curve C is less than the 6-hour turnover rate.

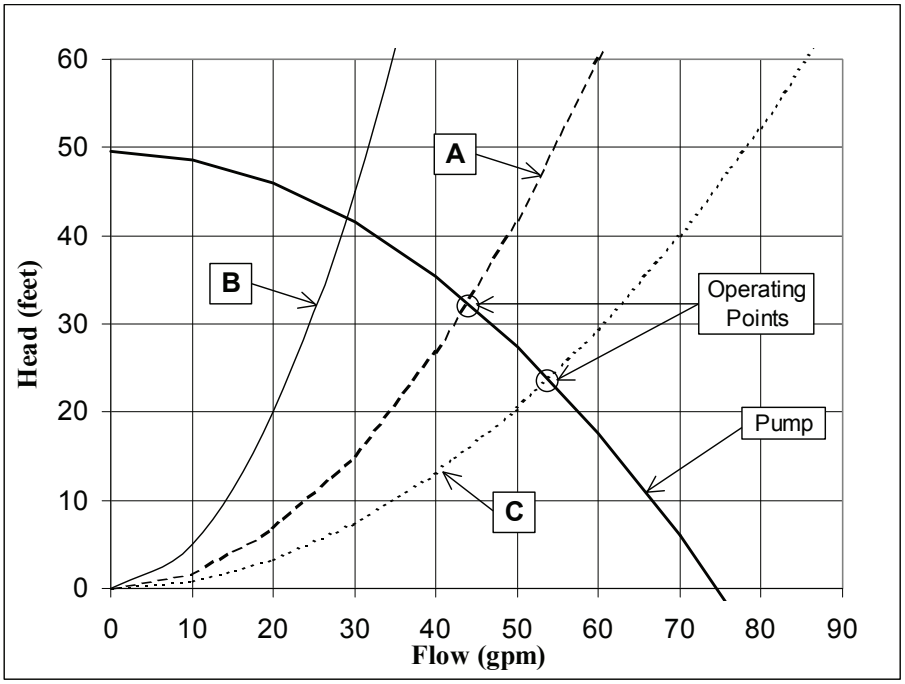

Figure 5-3 – System Test Curves

Pool Pump Controls

Pool controls are a critical element of energy efficient pool design. Modern pool controls allow for auxiliary loads such as cleaning systems, solar heating, and temporary water features without compromising energy savings.

§114(b)

A time switch or similar control mechanism must be installed as part of the pool water circulation control system that will allow all pumps to be set or programmed to run only during the off-peak electric demand period and for the minimum time necessary to maintain the water in the condition required by applicable public health standards.

§150 (p)1

Multi-speed pumps must have controls that default to the filtration flow rate when no auxiliary pool loads are operating. The controls must also default to the filtration flow rate setting within 24 hours and must have a temporary override capability for servicing.

Pool Pipe, Filter, and Valve Requirements

System design for residential pools is new for 2008. Correct sizing of piping, filters, and valves reduces overall system head, reduces noise and wear, and increases energy efficiency. Other mandatory requirements include leading straight pipe into the pump, directional inlets for mixing, and piping to allow for future solar installations.

§114(b) and §150(p)2

Pool piping must be sized according to the maximum flow rate needed for all auxiliary loads. The maximum velocity allowed is 8 fps in the return line and 6 fps in the suction line. Table 5-3 shows the minimum pipe sizes required by pool volume based on a 6-hour turnover filtration flow rate. These pipe sizes would need to be increased if there are auxiliary loads that operate at greater than the filtration flow rate. Conversely, they could be reduced if the pump is sized for greater than a 6-hour turnover filtration flow rate.

Table 5-3 – 6-Hour Turnover Pipe Sizing

Pool Volume (gallons)		**Minimum Pipe Diameter (in)**	
Min	Max	Return	Suction
-	13,000	1.5	1.5
13,000	17,000	1.5	2
17,000	21,000	2	2
21,000	30,000	2	2.5
30,000	42,000	2.5	3
42,000	48,000	3	3
48,000	65,000	3	3.5

There must be a length of straight pipe that is greater than or equal to at least 4 inches pipe diameters installed before the pump. That is, for a 2 inch suction pump, there must be at least 8 inches of straight pipe before the pump's strainer basket.

Traditional hard 90^{o} elbows are not allowed. All elbows must be sweep elbows or a type of elbow that has a pressure drop less than the pressure drop of straight pipe with a length of 30 pipe diameters. For example, a 2 inch elbow must have a pressure drop less than a 5-foot length of 2 inch straight pipe.

Field verification of sweep elbows may be performed by checking that the distance "w" of the installed sweep elbow is greater than that for a hard 90 elbow (refer to Figure 5-4). The difference in measurement between the radial edge of one sleeve to the perpendicular side of the elbow is found to be distinct between sweep elbows and hard 90's. There is sufficient difference in distance "w" such that all sweep elbows exceed the minimum values listed in Table 5-4.

Figure 5-4 below illustrates "w" the dimension between the elbow sleeves and Table 5-4 shows the minimum distances "w" for an acceptable sweep elbow.

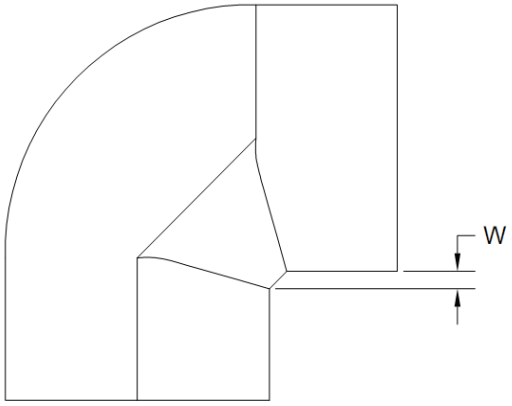

Figure 5-4 – Measuring "w" at the pool site.

Table 5-4 – Pool site measurement for sweep elbows

Pipe Diameter	Minimum W (inch)
1.5	3/8
2	1/2
2.5	5/8
3	3/4
4	1

Filters shall be sized using NSF/ANSI 50 based on the maximum flow rate through the filter. The filter factors that must be used are (in ft²/gpm):

Cartridge	0.375
Sand	15
Diatomaceous Earth	2

Backwash valves must be sized to the diameter of the return pipe or two inches, whichever is greater. Multiport backwash valves have a high pressure drop and are discouraged. Low-loss slide and multiple 3-way valves can provide significant savings.

The pool must have directional inlets to adequately mix the pool water.

If a pool does not currently use solar water heating, piping must be installed to accommodate any future installation. Contractors can choose three options to allow for the future addition of solar heating equipment:

1. Provide at least 36 inches of pipe between the filter and the heater to allow for the future addition of solar heating equipment.

2. Plumb separate suction and return lines to the pool dedicated to future solar heating.
3. Install built-up or built-in connections for future piping to solar water heating. An example of this would be a capped off tee fitting.

Example 5-4

Question

My pool has both a solar heater and a gas heater. Do I need to install a pool cover?

Answer

Yes. A cover is required for all pools with gas or electric heaters, regardless of whether they also have a solar heater.

Example 5-5

Question

I have a 25,000 gallon pool and want to use a two-speed pump with a Curve C flow rate of 79gpm on high-speed and 39gpm on low-speed. Is this okay and what size pipe must I install?

Answer

The maximum filtration flow rate for a 25,000 gallon pool is 69 gpm by using equation [Max Flow Rate (gpm) =Pool Volume (gallons) / 360minutes], so the pump is okay, as long as a control is installed to operate the pump on low-speed for filtration. The maximum pipe size must be based on the maximum flow rate, which is 79 gpm, so referencing Table 5.3, you must use 2.5 inch suction and 2 inch return piping.

5.3 Prescriptive Requirements

5.3.1 Pipe Insulation on Lines to Kitchen

§ 151(f)8 D

It is a prescriptive requirement that all hot water pipes run from the heating source to the kitchen fixtures be insulated. The amount of insulation required (typically one inch) is described above under mandatory requirements. Since this is a prescriptive requirement, it may be possible to comply without insulation if the water heating system as a whole meets the performance standard described in §151(b)1 or if the building as a whole complies under the performance method.

5.3.2 Systems Serving Individual Dwelling Units

Package D and E

§151(b)1 or 151(f)8

To meet the prescriptive requirements of Package D and E, systems serving individual dwelling units the water heater shall have a single gas, propane or oil

storage type water heater with an input capacity less than or equal to 75,000 Btu/h or a single gas, propane or oil instantaneous water heater with an input capacity less than or equal to 200,000 Btu/h is also acceptable. Either of these water heaters can be combined with a standard trunk and branch distribution system with the kitchen pipes insulated. Acceptable alternative distribution systems that can be used for prescriptive compliance include parallel piping and on demand recirculation with manual controls. If the demand recirculation with manual controls is used a buffer tank cannot be installed. No other type of recirculation system may be used with prescriptive compliance. Exterior tank insulation is only required for storage gas water heaters with an Energy Factor (EF) equal to the minimum federal standard.

The other option under the prescriptive compliance method is to meet the TDV energy budget for water heating as described in §151(b)1. This path requires a rather detailed calculation that is only practical using computer compliance programs. However, Table 5-5 shows a few alternative water heater systems that have been precalculated to comply when serving a single dwelling unit. These are only a few of many possible combinations that will comply.

Table 5-5 – Pre-approved Alternative Water Heating Systems for Single Dwelling Units (Equivalent to prescriptive requirement)

System Type	System Approved
Multiple (more than one) Instantaneous gas or propane with no pilot light and an energy factor of 0.85 or greater	YES
Heat pump water heater of 50 gallons or less with an energy factor of 2.5 or greater with a solar system contributing at least 25% of the total water heating requirements	YES
Two 50 gallon or less storage gas or propane fired units each with energy factor of 0.67 or greater and pipe insulation	YES
Storage gas of 50 gallons or less with an energy factor of 0.59 or greater with Parallel Piping	YES
Storage Gas of 50 gallons or less with an energy factor of 0.62 or greater with Demand Recirculation	YES
Storage Gas of 50 gallons or less with an energy factor of 0.58 or greater with time and temperature recirculation control and a solar system contributing at least 25% of the total water heating energy use	YES
50 Gal Electric with an energy factor of 0.94 or greater, pipe insulation and solar with at least a 60% solar fraction.	YES (only in areas where natural gas is not available)
Water Heater heat pump of 50 gallons or less with an energy factor of 2.5 or greater and pipe insulation	YES (only in areas where natural gas is not available)

Package C

If Package C is used for overall compliance, an electric water heater is permitted only if it meets the following requirements:

- Storage tank capacity is 50-gallon or less;
- Standard or point of use distribution system (non-recirculating);
- Water heater is located within the building envelope; and

- A solar system that provides at least 25 percent of the annual water heating requirements.

Example 5-6

Question

How do the Standards apply to a single family residence with a single 40-gallon gas water heater and norecirculating system?

Answer

This qualifies as a standard water heating system and complies automatically. No water heating calculations are required, although they may be performed to take credit for a particularly efficient water heater.

Example 5-7

Question

A 1,800 ft² single family residence has two identical 30-gallon gas storage tank water heaters and a point of use distribution system. Does this comply?

Answer

Because there are two water heaters, this system does not meet the standard prescriptive water heating systems requirements of §151(f)8. The system must be shown to meet the water heating budget of §151(b)1. The precalculated values in Table 5-5 above shows that if two 50 gallon water heaters where used with energy factors of 0.67 in combination with insulating the entire distribution systems would comply. It is very possible that the described system might meet the energy budget if performance was used.

Example 5-8

Question

A 6,000-ft² single family residence has 3 storage gas water heaters (40 gallon, 30 gallon and a 100-gallon unit with 80,000 Btu/h input). Does it comply?

Answer

A performance calculation is required since the system does not meet the standard requirements and must be shown to meet the water heating budget of §151(b)1.

Example 5-9

Question

A single family residence has one non-recirculating 50-gallon gas water heater. The water heater has an input rating of 76,000 Btu/hr. Does it comply?

Answer

Under the 2005 Standards this approach would have complied; however, since the input rating is greater than 75,000 Btu/hr the unit is not covered under the federal EF guidelines. For this system to demonstrate compliance, the performance method must be used.

5.3.3 Systems Serving Multiple Dwelling Units

To meet the prescriptive requirements, water heaters that serve multiple dwelling units must be gas, oil, or propane central recirculating systems. Any number of water heaters may be used and any size may be used as long as they are equipped with timer controls and meet the mandatory measure minimum efficiency requirements of §111 or §113.

Recirculating systems may be used as long as they have controls to turn off the pumps when hot water is not needed (e.g., timer controls). Pipes must be insulated as described earlier under mandatory requirements.

Any system not meeting these prescriptive requirements must instead meet the water heating performance budget as described in §151(b)1, or must follow the performance compliance method for the building as a whole. In this case, it is important to note a change in the Compliance Software calculations for 2005. Previously, the performance baseline was an individual water heater for each unit in a multifamily building, regardless of the proposed system configuration. In the 2005 standards, the baseline is a central water heating system whenever the proposed system serves multiple dwelling units. The result of this change is that the water heating budget will turn out to be more stringent than in the past for systems serving multiple dwellings.

Example 5-10

Question

A 10-unit multifamily building has separate gas water heaters for each dwelling unit. Five units have 30-gallon water heaters, and 5 units have 50-gallon water heaters. Does this comply?

Water heating calculations are not required if each system is non-recirculating and each water heater has a 0.58 or higher EF, because each dwelling unit has a standard water heating system.

Example 5-11

Question

We are building an 8-unit, 7,800 ft² multifamily building with a 200 gallon storage gas water heater with a time and temperature controlled recirculation system that has R-4 insulation on all the piping. The system serves all the units. Do I have to perform calculations to show compliance?

Answer

Water heating calculations are not needed because this system meets all the requirements of §151(f)8.

Example 5-12

Question

We are building a 10-unit apartment building with a single large water heater. We do not plan to install a recirculation pump and loop. Does this meet the Prescriptive requirements?

Answer

No. Since it is unlikely that a non-recirculating system will satisfactorily supply hot water to meet the tenants' needs, a recirculating system must be installed to meet the Prescriptive requirements. There is an exception for multifamily buildings of six units or less using the performance approach. For central hot water systems serving six or fewer dwelling units which have (1) less than 25 feet of distribution

piping outdoors; (2) zero distribution piping underground; (3) no recirculation pump; and (4) insulation on distribution piping that meets the requirements of §150(j), the distribution system in the Standard Design and Proposed Design will both assume a pump with timer controls.

5.3.4 Pipe Insulation Below Grade

§151(f)8.E.

It is a prescriptive requirement that all hot water pipes run below grade must be insulated to the requirements of §150(j) and be installed in a waterproof and non-crushable casing or sleeve that allows for the installation, removal, and replacement of the enclosed pipe and insulation. Examples of acceptable casing materials include PVC and ABS pipe. Allowing for pipe removal implies the use of flexible hot water piping such as PEX. One exception to the insulation requirements of §150(j) involves island sinks commonly found in kitchens. In the case of island sinks, 1/2 inch wall thickness insulation within the casing material is acceptable for a maximum run length of 15 feet.

5.4 Compliance Options

5.4.1 Performance Compliance

The computer performance approach allows for the modeling of water heating system performance based on system type and efficiency, fuel type, distribution system type (and control options), and auxiliary systems that do not necessarily meet the prescriptive requirements.

5.4.2 Auxiliary Systems

The Water Heating Calculation Method allows water heating credits for solar water heaters. Solar systems save energy by using nondepletable resources to offset the use of conventional energy sources.

Solar Water Heaters

As noted earlier, solar water heating is a mandatory requirement for State built buildings. A solar system is required in meeting the Package C prescriptive requirements when an electric resistance water heater is installed. For all other buildings, a water heating credit is available for both passive and active solar water heating systems when following the performance compliance path.

For solar water heating systems, an approved method must be used to determine the Solar Savings Multiplier. Two calculation approaches may be used. To determine the solar contribution of a solar water heating system that has been rated using the SRCC OG 300 procedure, use either form CF-SR which is located in Appendix A, or go to the Commission website at and download a spreadsheet form. For solar systems that are built up for single or multifamily buildings, a California version of F-chart is available at www.energy.ca.gov/title24/

Mandatory requirements for pipe insulation and storage tank insulation apply as described earlier in this chapter.

5.4.3 Combined Hydronic

Combined hydronic space heating systems utilize a single heat source to provide both space heating and domestic hot water. The system is evaluated for water heating performance as if the space heating function were separate. Section 4.7 provides an explanation of combined hydronic systems.

5.4.4 Distribution System Options

For systems serving individual dwelling units, the prescriptive requirement assumes pipe insulation on all hot water lines running from the water to the kitchen. This is a change from the 2005 Standards where only lines to the kitchen greater than or equal to 3/4 inch in diameter is assumed to be insulated.

There are three distribution system alternatives (Point of Use, Pipe Insulation (all lines), and Demand Recirculation with Manual Control) that offer credits in the performance compliance approach for systems serving individual dwelling units. Several distribution system options are assumed to be equivalent with the prescriptive case including parallel piping, insulated and protected pipes below grade, and demand recirculation with motion sensor control. Finally, most recirculation options, uninsulated pipes below grade, and standard piping without insulation all incur a penalty in the performance approach.

For systems serving multiple dwelling units with a recirculating pump, extra credit is available for additional insulation, as well as for having all the piping inside the building envelope. The standard system is assumed to have R-4 insulation on piping up to 2 inch, R-6 insulation on piping over 2 inch in diameter, no piping underground, and only 5 percent of the piping outside.

More detailed description of the eligibility criteria of the various distribution system options can be found in Reference Residential Appendix RA4.4.

Example 5-13

Question

Can I get pipe insulation credit for a recirculating water-heating system?

Answer

Not for systems serving a single dwelling unit. Recirculating water heating systems have a mandatory insulation requirement for the recirculating section of the hot water pipes. Pipes less than 2 inch must be insulated to R-4 and pipes greater than 2 inch need R-6 insulation. For systems serving multiple dwelling units, using R-6 where R-4 is required, and R-8 where R-6 is required, results in credit within the performance approach. All the circulation loop pipes in one location type (e.g., inside, outside, underground) must be insulated to the higher level to qualify.

5.4.5 Instantaneous Gas Water Heaters

A PIER-sponsored evaluation of instantaneous (or tankless) gas water heaters was completed to assess whether the rated energy factor for these units

accurately describes real world system performance. Results of the study indicate that the energy factor test procedure underestimates the impact of small volume hot water draws and heat exchanger cycling on annual system performance. Based on these findings, the 2008 Standards will apply a 0.92 derating factor on the nominal EF of all gas instantaneous water heaters.

Instantaneous gas water heaters may not be used in combination with a storage tank, regardless of the distribution system type. Depending on how the system is configured this combination can result either relatively high energy efficiency or may actually increase energy use substantially. Another reason for not allowing this combination is that the current modeling rules in the Compliance Software are not capable of properly modeling this configuration.

5.5 Compliance and Enforcement

Chapter 2 addresses the compliance and enforcement process in a general manner and discusses the roles and responsibilities of each of the major parties, the compliance forms, and the process for field verification and/or diagnostic testing. This section highlights compliance enforcement issues for water heating systems.

5.5.1 Design

The initial compliance documentation consists of the Certificate of Compliance (CF-1R) and the mandatory measures (CF-6R). These documents are included on the plans and specifications. The CF-1R has a section where special features are listed. The following are water heating features that should be listed in this section of the CF-1R, if they exist in the proposed design:

- Any system type other than one water heater per dwelling unit
- Non-NAECA large water heater performance
- Indirect water heater performance
- Instantaneous gas water heater performance
- Distribution system type and controls
- Solar system
- Combined hydronic system
- Any multifamily building with a central water heating and distribution system where some dwelling units are served by an individual water heater

5.5.2 Construction

During the construction process, the contractor and/or the specialty contractors complete the necessary sections of the Installation Certificate (CF-6R). For water heating there is only one section to be completed where information about the installed water heating system is entered.

Inspectors should check that the number and types of water heater systems indicated on the CF-6R, corresponds to the approved CF-1R. The distribution system is also significant and must correspond to plan specifications. For example:

1. If a recirculation system is installed, verify that it was accounted for in the compliance documentation (CF-1R) and check for any required components and/or controls (e.g., pipe insulation, timer, push buttons for demand control recirculation system).
2. If the water heating systems serves more than one dwelling unit, verify the total length of the distribution loop, the length of the loop in each of the three location types (inside, outside, underground), and the amount of insulation on the piping in each location.
3. If a point of use credit is specified, the water heater must be no further than 8 ft (plan view) from all hot water use points, with the exception of washing machines.
4. Verify that the make and model number of the installed water heater unit matches that listed on the Installation Certificate (CF-6R).
5. Verify installation of a timer control or a time and temperature control on a multifamily building with central water heating and recirculating system.

For most central water heating distribution systems in multifamily buildings, any distribution systems for supplying hot water from a central boiler or water heater should be assumed to have a recirculation pump and assume that one would be supplied retroactively if not initially.

For central hot water systems serving six or fewer dwelling units that have:

1. Less than 25 ft of distribution piping outdoors;
2. Zero distribution piping underground;
3. No recirculation pump; and
4. Insulation on distribution piping that meets the requirements of §150(j), a pump and timer are not required to be installed. When calculating the energy use of these multifamily distribution systems, the distribution system in the Standard Design and Proposed design will both be assumed to have a pump with timer controls even when one is not installed.

5.5.3 Field Verification and/or Diagnostic Testing

The only element of a water heating system that requires field verification is where insulation credit is taken for hot water pipes located in the attic and buried by ceiling insulation. In this case, a field inspector must verify that the Eligibility requirements for pipe insulation have been met.

5.6 Glossary/Reference

Relevant terms are defined in Reference Joint Appendix JA1.

The following are terms that are either not defined in JA1 or expansions to the Appendix I definitions.

Energy Factor (EF) of a water heater is a measure of overall water heater efficiency, as determined using the applicable test method in the Appliance Efficiency Regulations. EF is applicable for most residential water heaters with the criteria specified in the Appliance Efficiency Regulations. Typical gas storage water heaters have an EF of about 0.60, electric storage water heaters approximately 0.90, and gas instantaneous units approximately 0.80.

External tank insulation can be applied to the exterior of storage type water heater tanks. When installed, water heater insulation should be applied to completely cover the exterior of the water heater, but should not conceal controls or access ports to burners, obstruct combustion air openings, or interfere in any way with safe water heater operation. Insulation of top and bottom surfaces is not necessary.

Recovery energy is the energy used to heat water.

Recovery load is the load on the water heater due to hot water end uses and distribution losses.

Thermal efficiency is defined in the Appliance Efficiency Regulations as a measure of the percentage of heat from the combustion of gas or oil that is transferred to the hot water as determined using the applicable test methods.

5.6.1 Water Heater Types

Storage Gas. A gas water heater designed to heat and store water at less than 180°F. Water temperature is controlled with a thermostat. Storage gas water heaters have a manufacturer's specified storage capacity of at least 2 gallons and input capacity less than or equal to 75,000 Btu/h.

Large Storage Gas. A storage gas water heater with input capacity greater than 75,000 Btu/h.

Storage Electric. An electric water heater designed to heat and store water at less than 180°F. Water temperature is controlled with a thermostat. Storage electric water heaters have a manufacturer's specified storage capacity of at least two gallons.

Storage Heat Pump. An electric water heater that uses a compressor to transfer thermal energy from one temperature level to a higher temperature level for the purpose of heating water. It includes all necessary auxiliary equipment such as fans, storage tanks, pumps or controls. Energy Factors for heat pump water heaters are found in the Energy Commission’s Appliance Database under Certified Water Heaters.

Instantaneous Gas. A gas water heater controlled manually or automatically by a water flow activated control or a combination of water flow and thermostatic controls, with a manufacturer's specified storage capacity of less than 2 gallons. Most gas tankless units, as they are more commonly called, have modulating output capacity and spark ignition.

Instantaneous Electric. An electric water heater controlled automatically by a thermostat, with a manufacturer's specified storage capacity of less than 2 gallons.

Note: Instantaneous water heaters are not generally designed for use with solar water heating systems or as heat sources for indirect fired water heaters. They are also typically inappropriate for use with recirculation systems. Consult manufacturer's literature when considering these applications.

Indirect Gas. A water heater consisting of a storage tank with no heating elements or combustion devices, connected via piping and recirculating pump to a heat source consisting of a gas or oil fired boiler, or instantaneous gas water heater (see note following the definitions of Instantaneous Gas and Electric).

As described above in the section on Mandatory Requirements, the storage tank must be insulated in accordance with §150(j)1B, which requires a factory-installed minimum of R-16 (labeled on outside of tank) or a minimum of R-12 external insulation.

The piping connecting the heating source and the storage tank must also meet the mandatory requirements, typically one inch of R-4 insulation. This includes any piping located in concrete slabs or underground.

5.6.2 Distribution Systems

The water heating distribution system is the configuration of piping (and pumps and controls in the case of recirculating systems) that delivers hot water from the water heater to the end use points within the building. The water heating performance method provides credits for energy efficient distribution systems, while assigning penalties for less energy efficient systems.

Standard Distribution System

Systems Serving Single Dwelling Units

A standard distribution system serving a single dwelling unit is defined as a trunk and branch system that does not incorporate a pump for hot water recirculation, and does not take credit for any design features eligible for energy credits. As per the prescriptive requirements, all pipes running to the kitchen must be insulated to meet the requirements of a standard distribution system.

Installation Criteria

No pumps may be used to recirculate hot water. The first 5 ft of hot and cold water piping adjacent to the water heater must be insulated according to mandatory requirements.

Systems Serving Multiple Dwelling Units

The standard distribution system for water heaters serving multiple dwelling units incorporates a recirculation pump, controls to shut the pump off when it is not needed, and insulation on all portions of the recirculation loop. As required by the prescriptive approach, the piping to the kitchen must also be insulated.

Standard Pipes with No Insulation

This case is the same as the standard distribution system defined above, except the hot water lines to the kitchen are not insulated.

Point of Use

A point of use distribution system design minimizes the volume of water between the water heater and the hot water use points. This credit is not applicable to systems serving multiple dwelling units.

Installation Criteria

The distance between the water heater and any fixture using hot water cannot exceed 8 ft, measured in plain view (see Figure 5-5).

All water heaters and hot water fixtures must be shown on plans submitted for local building department plan check.

Exception: Washing machines for clothing may be located more than 8 feet from the water heater.

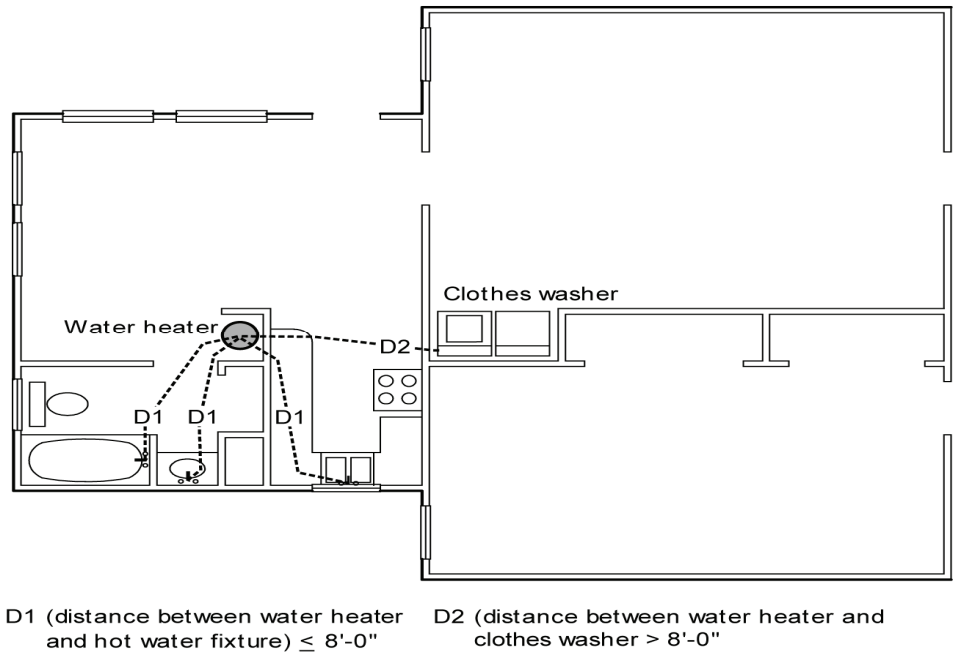

Figure 5-5 – Point of Use Distribution System

Pipe Insulation

For systems serving a single dwelling unit, the pipe insulation credit applies only to non-circulating systems. For systems serving multiple dwelling units, there is a pipe insulation credit for recirculating piping external to dwelling units if pipes are insulated to a higher R-value than the mandatory minimum.

Installation Criteria (Single Dwelling Unit)

Insulation must meet the level required in the mandatory requirements. Note that pipes buried under ceiling insulation can meet the mandatory requirements.

Note: Heat tape – electric resistance heating tape wrapped around hot water pipes – may be used only for freeze protection and cannot be used instead of mandatory pipe insulation (see §150(j)) or pipe insulation receiving distribution credit.

Installation Criteria (Multiple Dwelling Units)

All piping in the same location type (inside, outside, or underground) must be insulated to at least R-6 for pipes up to 2 inch in diameter, or R-8 for pipes larger than 2 inch in diameter.

Pipe insulation for piping located underground or in a slab must be protected by a material that is resistant to compression and crushing, so that the insulation value is maintained after installation of covering materials.

Parallel Piping

The intent of a parallel piping, or manifold distribution system is to minimize the volume of water entrained in piping between the water heater and the end use points. This system typically has a 3/4 inch or 1 inch line from the water heater to a manifold which then feeds individual hot water use points with 3/8 inch or 1/2 inch plastic (e.g. PEX) tubing.

Credit for Parallel Piping can only be used if each hot water use point (each kitchen, each bathroom and each laundry area) has a separate distribution line with a maximum size of half-inch pipe run from the location of the water heater to each hot water use location. This credit does not apply to systems serving multiple dwelling units.

Installation Criteria

The 2008 Standards specify a maximum 15 foot pipe length from the water heater to the manifold (minimizing this length further is highly advantageous, as most of the water in a parallel piping system is located upstream of the manifold). In addition, the hot water line feeding the manifold must be insulated to R-4. Piping from the manifold must take the most direct path to the use point. In homes with two or more stories, piping serving first floor use points must not go above the second floor. See Reference Residential Appendix RA4.4 for detailed criteria.

Recirculation System – No Control

A distribution system without controls in which the pump continually recirculates hot water though a recirculation loop. The “no control” recirculation strategy is the most energy inefficient of the recirculation strategies.

Installation Criteria

All piping used to recirculate hot water must be insulated to meet the mandatory requirements (§150(j)). This includes any recirculating piping located in concrete slabs or underground. Since the Standards require pipe insulation for recirculating systems, these systems are not eligible for the Pipe Insulation credit. For systems serving a single dwelling unit, the recirculating loop within a dwelling unit must be laid out to be within 8 ft of all hot water fixtures served by the recirculating loop.

As with all recirculation systems, an intelligent loop layout (loop in-board of hot water use points) and proper insulation installation is essential in obtaining desired performance.

Recirculation System – Temperature Control

Recirculation system control option that uses a return line temperature sensor to control the recirculating pump to maintain return water temperatures within certain limits.

Installation Criteria

All criteria listed for continuous recirculation systems apply.

An automatic thermostatic control must be installed to cycle the pump on and off in response to a temperature sensor installed on the water heater return line. Minimum differential or "deadband" of the control shall not be less than 20°F. In this case, the pump may run continuously.

Plans must indicate pump and temperature control.

Recirculation System – Timer Control

A recirculation system that uses a timer control to cycle pump operation based on time of day.

Installation Criteria

All criteria listed for continuous recirculation systems apply.

A timer must be permanently installed to regulate pump operation. Timer setting must cycle the pump off for at least eight hours every day.

Plans must indicate pump and timer control.

Recirculation System – Timer and Temperature Control

A recirculation system that uses both temperature and timer controls to regulate pump operation, so that the pump is cycled off during periods when the return line water temperature exceeds the minimum temperature, as well as for the eight hour timer lockout period.

Installation Criteria

All criteria listed for continuous, temperature controlled, and timer controlled recirculation systems apply.

Recirculation System – Demand Control

A recirculation system that uses brief pump operation in response to a hot water demand signal to circulate hot water through the recirculation loop. The system must have a remote temperature sensor, typically located at the most remote point of the recirculation loop that terminates pump operation when the sensed temperature rises. Typical control options include manual push button controls or occupancy sensor controls. Push button control is preferred from a performance

perspective, since it will eliminate “false signals” for pump operation that an occupancy sensor will generate.

Installation Criteria

All criteria listed for continuous recirculation systems apply.

Pump start-up must be provided by a push button, occupancy sensor or flow switch.

Pump shut-off must be provided by either a temperature sensing device that shuts off the pump when hot water reaches the location of use, or by a timer which limits pump run time to two minutes or less.

For a system serving a single dwelling, push buttons and sensors must be installed in all locations with a sink, shower, or tub, with the exception of the laundry room.

Plans must include a wiring/circuit diagram for the pump and timer/temperature sensing device and specify whether the control system is manual (push button or flow switch) or other control means, such as occupancy sensor.

Temperature Buffering Tank

Temperature buffering tanks are small storage tanks (typically less than 5 gallons) that are installed downstream of the water heater. In most cases, these tanks are installed with instantaneous (tankless) gas water heaters to address the “cold sandwich” problem that may occur.

Installation Criteria

The tank set point should be set below 110°F.

5.6.3 Pool and Spa Equipment

Flow Rate. Flow rate is the volume of water flowing through the filtration system in a given time, usually measured in gallons per minute.

Nameplate Power. The nameplate power is the motor horsepower (hp) listed on the nameplate and the horsepower by which a pump is typically sold.

Pumps. Pool pumps usually come with a leaf strainer before the impeller. The pumps contain an impeller to accelerate the water through the housing. The motors for residential us pumps are included in the pump purchase but can be replaced separately. The pumps increase the “head” and “flow” of the water. Head is necessary to move fluid through pipes, drains, and inlets, push water through filters and heaters, and project it through fountains and jets. Flow is the movement of the water used to maintain efficient filtering, heating, and sanitation for the pool.

Return. The return refers to the water in the filtration system returning to the pool. The return lines or return side, relative to the pump, can also be defined as the pressure lines or the pressure side of the pump. Water in the returns is delivered back to the pool at the pool inlets.

Service Factor. The service factor rating indicates the percent above nameplate horsepower at which a pump motor may operate continuously when full rated voltage is applied and ambient temperature does not exceed the motor rating.

Full-rated pool motor service factors can be as high as 1.65. A 1.5 hp pump with a 1.65 service factor produces 2.475 hp (total hp) at the maximum service factor point.

Suction. Suction created by the pump is how the pool water gets from the skimmers and drains to the filtration system. The suction side and suction lines refer to the vacuum side of the pump. It is at negative atmospheric pressure relative to the pool surface.

Total Dynamic Head. Total dynamic head, or TDH, refers to the sum of all the friction losses and pressure drops in the filtration system from the pools drains and skimmers to the returns. It is a measure of the system's total pressure drop and is given in units of either psi or feet of water column (sometimes referred to as "feet" or "feet of head").

Total Motor Power. Total motor power, or T-hp, refers to the product of the nameplate power and the service factor of a motor used on a pool pump.

Turnover. A turnover is the act of filtering one volume of the pool.

Turnover Time (also called Turnover Rate). The time required to circulate the entire volume of water in the pool or spa through the filter. For example, a turnover time of 6-hours means an entire volume of water equal to that of the pool will be passed through a filter system in six hours.

$$\text{Turnover Time} = \frac{\text{Volume of the pool}}{\text{Flow rate}}$$